WHAT IS CLAIMED IS:

1. An on-board fuel cell system adapted to be installed on a motor vehicle, comprising:

a hydrogen-gas storage device including a hydrogen-gas absorbing alloy capable of absorbing or releasing a hydrogen gas;

a fuel cell that is supplied with the hydrogen gas discharged from the hydrogen-gas storage device, so as to generate electric power, while discharging a remaining portion of the hydrogen gas;

a first passage that connects an outlet of the hydrogen-gas storage device with an inlet of the fuel cell, and allows the hydrogen gas discharged from the hydrogen-gas storage device to flow therethrough to be supplied to the fuel cell;

a second passage that connects an outlet of the fuel cell with a first point in the first passage, and allows the hydrogen gas discharged from the fuel cell to flow therethrough to be returned to the first passage;

a pump that is disposed in the second passage, and is operable to force the hydrogen gas in the second passage to flow toward the first point in the first passage;

a third passage that connects a second point located in the first passage between an outlet of the hydrogen-gas storage device and the first point, with a third point located in the second passage between the outlet of the fuel cell and the pump, the third passage allowing the hydrogen gas diverting from the first passage to flow therethrough to be fed to the second passage;

a first valve that is disposed in the first passage between the second point and the first point, and is able to permit and inhibit flow of gas therethrough upon opening and closing thereof, respectively;

a second valve that is disposed in the second passage between the outlet of the fuel cell and the third point, and is able to permit and inhibit flow of gas therethrough

upon opening and closing thereof, respectively;

a third valve that is disposed in the third passage, and is able to permit and inhibit flow of gas therethrough upon opening and closing thereof, respectively; and

a controller that controls the pump and the first, second and third valves, wherein:

when a pressure of the hydrogen gas discharged from the hydrogen-gas storage device is higher than a reference pressure, the controller opens the first and second valves and closes the third valve, so that the hydrogen gas discharged from the hydrogen-gas storage device is supplied to the fuel cell through the first passage, and the hydrogen gas discharged from the fuel cell is returned to the first passage through the second passage, with the pump circulating the hydrogen gas; and

when the pressure of the hydrogen gas discharged from the hydrogen-gas storage device is lower than the reference pressure, the controller closes the first and second valves and opens the third valve, and causes the pump to draw the hydrogen gas out of the hydrogen-gas storage device and feed the hydrogen gas from the first passage to the second passage through the third passage, so that the hydrogen gas is supplied from the second passage to the fuel cell through the first passage.

2. The on-board fuel cell system according to claim 1, wherein at least one of the first and second valves includes a reverse-flow preventing device that inhibits the hydrogen gas from flowing from the fuel cell toward the hydrogen-gas storage device.

3. The on-board fuel cell system according to claim 1, wherein the pump is driven at a first speed for circulating the hydrogen gas, and is driven at a second speed higher than the first speed for drawing the hydrogen gas out of the hydrogen-gas storage device.

4. The on-board fuel cell system according to claim 1, further comprising a pressure reducing device that is disposed between the outlet of the hydrogen-gas storage device and the first point in the first passage, and is operable to reduce a pressure of the hydrogen gas discharged from the hydrogen-gas storage device.

5. The on-board fuel cell system according to claim 4, further comprising:

a fourth passage that extends from a particular point in the first passage between the pressure reducing device and the inlet of the fuel cell, toward an outside of the vehicle; and

a relief valve that is disposed in the fourth passage, and is able to permit and inhibit flow of gas therethrough upon opening and closing thereof, respectively, wherein

when a pressure of the hydrogen gas in a portion of the first passage between the pressure reducing device and the fuel cell is higher than a reference pressure, the relief valve is opened so that the hydrogen gas is discharged from the first passage to the outside of the vehicle through the fourth passage.

6. The on-board fuel cell system according to claim 1, further comprising a gas-liquid separator that is disposed in at least one of the first and second passages, and is operable to separate a moisture contained in the hydrogen gas discharged from the fuel cell into a liquid component and a gaseous component, and remove only the liquid component.

7. An on-board fuel cell system adapted to be installed on a motor vehicle, comprising:

a hydrogen-gas storage device capable of discharging a hydrogen gas stored therein at a predetermined pressure;

a fuel cell that is supplied with the hydrogen gas discharged from the hydrogen-gas storage device, so as to generate electric power;

a first passage that connects an outlet of the hydrogen-gas storage device with an inlet of the fuel cell, and allows the hydrogen gas discharged from the hydrogen-gas storage device to flow therethrough to be supplied to the fuel cell;

at least one pressure reducing device disposed in the first passage to reduce a pressure of the hydrogen gas discharged from the hydrogen-gas storage device;

a second passage that extends from a particular point located in the first passage between the at least one pressure reducing device and the inlet of the fuel cell, toward an outside of the vehicle; and

a relief valve that is disposed in the second passage, and is able to permit and inhibit flow of gas therethrough upon opening and closing thereof, respectively, wherein

when a pressure of the hydrogen gas that exists in a passage that is closer to the particular point than the relief valve is higher than a reference pressure, the relief valve is opened so that the hydrogen gas is discharged from the first passage to the outside of the vehicle through the second passage.

8. The on-board fuel cell system according to claim 7, wherein an outlet of the second passage is positioned such that the hydrogen gas discharged from the second passage is directed toward a road surface.

9. An on-board fuel cell system adapted to be installed on a motor vehicle, comprising:

a hydrogen-gas supply device that supplies a hydrogen gas;

a fuel cell that is supplied with the hydrogen gas discharged from the hydrogen-gas supply device, so as to generate electric power, while discharging a remaining

portion of the hydrogen gas;

a first passage that connects an outlet of the hydrogen-gas supply device with an inlet of the fuel cell, and allows the hydrogen gas discharged from the hydrogen-gas supply device to flow therethrough to be supplied to the fuel cell;

a second passage that connects an outlet of the fuel cell with a particular point in the first passage, and allows the hydrogen gas discharged from the fuel cell to flow therethrough to be returned to first passage; and

a gas-liquid separator that is disposed in the second passage, and is operable to separate a moisture contained in the hydrogen gas discharged from the fuel cell into a liquid component and a gaseous component, and remove only the liquid component.

10. An on-board fuel cell system adapted to be installed on a motor vehicle, comprising:

a hydrogen-gas supply device that supplies a hydrogen gas;

a fuel cell that is supplied with the hydrogen gas discharged from the hydrogen-gas supply device, so as to generate electric power, while discharging a remaining portion of the hydrogen gas;

a first passage that connects an outlet of the hydrogen-gas supply device with an inlet of the fuel cell, and allows the hydrogen gas discharged from the hydrogen-gas supply device to flow therethrough to be supplied to the fuel cell;

a second passage that connects an outlet of the fuel cell with a particular point in the first passage, and allows the hydrogen gas discharged from the fuel cell to flow therethrough to be returned to first passage; and

a gas-liquid separator that is disposed in the first passage, and is operable to separate a moisture contained in the hydrogen gas discharged from the fuel cell into a liquid component and a gaseous component, and remove only the liquid component.

11. An on-board fuel cell system adapted to be installed on a motor vehicle, comprising:

a hydrogen-gas storage device capable of discharging a hydrogen gas stored therein at a predetermined pressure;

a fuel cell that is supplied with the hydrogen gas discharged from the hydrogen-gas storage device, so as to generate electric power;

a first passage that connects an outlet of the hydrogen-gas storage device with an inlet of the fuel cell, and allows the hydrogen gas discharged from the hydrogen-gas storage device to flow therethrough to be supplied to the fuel cell;

at least one pressure reducing device disposed in the first passage to reduce a pressure of the hydrogen gas discharged from the hydrogen-gas storage device;

a temperature raising device that is disposed in the first passage between one of the at least one pressure reducing device and the inlet of the fuel cell, and is operable to raise a temperature of the hydrogen gas flowing through the first passage.

12. An on-board fuel cell system adapted to be installed on a motor vehicle, comprising:

a hydrogen-gas supply device that supplies a hydrogen gas;

a fuel cell that is supplied with the hydrogen gas discharged from the hydrogen-gas supply device, so as to generate electric power, while discharging a remaining portion of the hydrogen gas, the fuel cell having a plurality of channels through which the hydrogen gas flows;

a first passage that connects an outlet of the hydrogen-gas supply device with an inlet of the fuel cell, and allows the hydrogen gas discharged from the hydrogen-gas supply device to flow therethrough to be supplied to the fuel cell;

a second passage that connects an outlet of the fuel cell with a particular point in the first passage, and allows the hydrogen gas discharged from the fuel cell to flow

therethrough to be returned to the first passage;

a pump that is disposed in the second passage, and is operable to force the hydrogen gas in the second passage to flow toward the particular point in the first passage; and

a controller that controls the hydrogen-gas supply device and the pump, wherein

upon a start of the fuel cell system, the controller causes the hydrogen-gas supply device to deliver the hydrogen gas, while driving the pump so as to induce flow of the hydrogen gas through at least a portion of the first and second passages and the channels of the fuel cell, thereby to mix impurities existing in the channels with the hydrogen gas delivered from the hydrogen-gas supply device to provide a homogeneous mixture thereof.

13. The on-board fuel cell system according to claim 12, further comprising a gas-liquid separator that is disposed in at least one of the first and second passages, and is operable to separate a moisture contained in the hydrogen gas discharged from the fuel cell into a liquid component and a gaseous component, and remove only the liquid component.

14. The on-board fuel cell system according to claim 12, further comprising at least one pressure reducing device that is disposed between the outlet of the hydrogen-gas storage device and the particular point in the first passage, and is operable to reduce a pressure of the hydrogen gas discharged from the hydrogen-gas supply device.

15. The on-board fuel cell system according to claim 14, further comprising:

a third passage that extends from a particular point in the first passage between the at least one pressure reducing device and the inlet of the fuel cell, toward an

outside of the vehicle; and

a relief valve that is disposed in the third passage, and is able to permit and inhibit flow of gas therethrough upon opening and closing thereof, respectively, wherein

when a pressure of the hydrogen gas in a portion of the first passage between the pressure reducing device and the fuel cell is higher than a reference pressure, the relief valve is opened so that the hydrogen gas is discharged from the first passage to the outside of the vehicle through the third passage.

16. The on-board fuel cell system according to claim 14, further comprising a temperature raising device that is disposed in the first passage between one of the at least one pressure reducing device and the inlet of the fuel cell, and is operable to raise a temperature of the hydrogen gas flowing through the first passage.

17. A method of controlling an on-board fuel cell system adapted to be installed on a motor vehicle, including a hydrogen-gas storage device having a hydrogen-gas absorbing alloy capable of absorbing or releasing a hydrogen gas, and a fuel cell that is supplied with the hydrogen gas discharged from the hydrogen-gas storage device, so as to generate electric power, the on-board fuel cell system further including: (a) a first passage that connects an outlet of the hydrogen-gas storage device with an inlet of the fuel cell, and allows the hydrogen gas discharged from the hydrogen-gas storage device to flow therethrough to be supplied to the fuel cell, (b) a second passage that connects an outlet of the fuel cell with a first point in the first passage, and allows the hydrogen gas discharged from the fuel cell to flow therethrough to be returned to the first passage, (c) a pump that is disposed in the second passage, and is operable to force the hydrogen gas in the second passage to flow toward the first point in the first passage, (d) a third passage that connects a second point located in the first passage

between an outlet of the hydrogen-gas storage device and the first point, with a third point located in the second passage between the outlet of the fuel cell and the pump, the third passage allowing the hydrogen gas diverting from the first passage to flow therethrough to be fed to the second passage, (e) a first valve that is disposed in the first passage between the second point and the first point, and is able to permit and inhibit flow of gas therethrough upon opening and closing thereof, respectively, (f) a second valve that is disposed in the second passage between the outlet of the fuel cell and the third point, and is able to permit and inhibit flow of gas therethrough upon opening and closing thereof, respectively, and (g) a third valve that is disposed in the third passage, and is able to permit and inhibit flow of gas therethrough upon opening and closing thereof, respectively, the method comprising the steps of:

determining whether a pressure of the hydrogen gas discharged from the hydrogen-gas storage device is higher than a reference pressure;

when the pressure of the hydrogen gas is higher than the reference pressure, opening the first and second valves and closing the third valve, so that the hydrogen gas discharged from the hydrogen-gas storage device is supplied to the fuel cell through the first passage, and the hydrogen gas discharged from the fuel cell is returned to the first passage through the second passage, with the pump circulating the hydrogen gas; and

when the pressure of the hydrogen gas is lower than the reference pressure, closing the first and second valves while opening the third valve, and causing the pump to draw the hydrogen gas out of the hydrogen-gas storage device and feed the hydrogen gas from the first passage to the second passage through the third passage, so that the hydrogen gas is supplied from the second passage to the fuel cell through the first passage.

18. A method of controlling an on-board fuel cell system adapted to be installed

on a motor vehicle, including a hydrogen-gas storage device that supplies a hydrogen gas, and a fuel cell that is supplied with the hydrogen gas discharged from the hydrogen-gas supply device, so as to generate electric power, while discharging a remaining portion of the hydrogen gas, the fuel cell having a plurality of channels through which the hydrogen gas flows, the on-board fuel cell system further including: (a) a first passage that connects an outlet of the hydrogen-gas supply device with an inlet of the fuel cell, and allows the hydrogen gas discharged from the hydrogen-gas supply device to flow therethrough to be supplied to the fuel cell; (b) a second passage that connects an outlet of the fuel cell with a particular point in the first passage, and allows the hydrogen gas discharged from the fuel cell to flow therethrough to be returned to the first passage; and (c) a pump that is disposed in the second passage, and is operable to force the hydrogen gas in the second passage to flow toward the particular point in the first passage, the method comprising the steps of:

causing the hydrogen-gas supply device to deliver the hydrogen gas upon a start of the fuel cell system; and

driving the pump so as to induce flow of the hydrogen gas through at least a portion of the first and second passages and the channels of the fuel cell, thereby to mix impurities existing in the channels with the hydrogen gas delivered from the hydrogen-gas supply device to provide a homogeneous mixture thereof.

19. The method according to claim 18, wherein the on-board fuel cell system further includes a drain valve disposed in a third passage that diverges from the second passage and leads to an outside of the vehicle, the method further comprising the steps of:

determining whether an open-end voltage of the fuel cell has increased to a predetermined level;

connecting a load to the fuel cell if the open-end voltage of the fuel cell is equal

to or larger than the predetermined level; and

opening the drain valve for a predetermined period of time so as to discharge the mixture of the impurities and the hydrogen gas.